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for a

LOCATION QUERY SERVICE FOR WIRELESS NETWORKS

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THIRD PARTY LOCATION QUERY FOR WIRELESS NETWORKS

BACKGROUND

Field of the Invention

The present invention relates to the field of wireless networks, and in particular, to wireless networks that track the location of wireless network devices.

Background of the Invention

In compliance with regulations promulgated by the Federal Communications Commission (FCC), wireless networks will soon provide services that are able to determine the location of all network users. These federally mandated services, known as enhanced wireless 911 (E911) services, will require wireless telephones to provide 911 call centers, or Public Safety Answering Points (PSAPs), with vital information necessary to locate and identify a caller in an emergency. To comply with E911 standards, wireless network providers will track the location and identity information of all wireless callers, with the purpose of providing such information to emergency personnel when a caller dials 911 from a wireless telephone. The FCC's wireless E911 rules require certain Commercial Mobile Radio Services (CMRS) carriers to begin transmission of enhanced location and identity information in two phases. Phase I requires carriers to transmit a caller's telephone number and general location to a PSAP. Phase II requires carriers to provide more precise location information to the PSAP.

Under the FCC rules, wireless networks and the corresponding wireless handheld devices, such as cellular telephones, will provide both the identity and location of the caller to a 911 dispatcher. To provide a caller's identity, the wireless handheld device will furnish a mobile identification number (MIN), indicating in most instances the telephone number of the device. The wireless network and wireless handheld devices will provide the location of callers using a network-based location system (*e.g.*, triangulation), global positioning systems (GPSs) within the handheld devices, or a combination of the two systems.

Although, in large part, wireless network providers will implement the location tracking systems to comply with the FCC standards, once completed, the providers will have the ability to offer other location-based services supported by the E911 infrastructure. Indeed, beyond the needs of PSAPs in emergency situations, there are many instances in which it is helpful to know the location of a network user. For example, a service dispatcher monitoring the activities of his service technicians may wish to determine the exact locations of his technicians to facilitate efficient scheduling. Although, with conventional mobile telephone networks, the dispatcher could call and ask the technician for his location, the dispatcher may prefer to ascertain the location information without interrupting the technician's activities.

Other location tracking systems provide the ability to determine a person's location without communicating with (or interrupting) the person. However, these solutions require dedicated networks and network devices. For instance, although a

global positioning system can provide a person's location without contacting the person, the system requires that the party requesting the location information (referred to herein as the "requestor") have communication hardware that receives the location information from the person's GPS receiver. For example, in a typical fleet vehicle tracking system, the fleet manager must purchase and maintain a central processor that communicates with the GPS receiver in each vehicle.

SUMMARY OF THE INVENTION

The present invention is a location query service for use with a wireless network that tracks the location of network devices. The service provides requestors with the locations of network users, based on the locations of the users' wireless network devices. The service enables a requestor to obtain a network user's location without requiring communication with the user. In addition, the service relieves a requestor of the burden of purchasing and maintaining dedicated location tracking equipment by taking advantage of existing communication infrastructures, such as global computer networks, Public Switched Telephone Networks (PSTNs), and wireless networks (with their soon-to-be-implemented location systems).

According to a preferred embodiment of the present invention, the location query service receives a location query from a requestor for a network user, retrieves the location information of the network user, and returns the location information to the requestor. Preferably, the requestor is an authorized requestor

and the service authenticates that the requestor is authorized before returning the location information to the requestor. Within the query, the requestor provides an identification of the network user, such as a name, telephone number, Internet address, or electronic mail (email) address. The service of the present invention supports a variety of communication methods through which a requestor can submit a location query, for example, voice calls through the Public Switched Telephone Network (PSTN) to an interactive voice response unit (IVRU), personal computer access through a global computer network, and cellular telephone access through a global computer network.

In processing location queries, a preferred embodiment of the present invention gives the network user control of who can receive his location information. The network user provides the service with a list of authorized requestors who may receive the user's location information. The service authenticates that a requestor is authorized before forwarding location information.

In an alternate preferred embodiment of the present invention, the location query service prompts a network user each time an unauthorized requestor asks for location information. An unauthorized requestor is a requestor who is not designated on a network user's list of authorized requestors and who has not been pre-approved to receive the user's location information. With these "off-list" requests, the network user permits or denies access for unauthorized (off-list) requestors on an individual basis, while automatically permitting access by authorized (on-list) requestors.

In a preferred embodiment, the system of the present invention includes a user wireless network and a location server. The user wireless network is in communication with a plurality of network devices operated by a plurality of network users. The user wireless network is also in communication with a location system for determining the location of each network device. The location server is in communication with the wireless network and with a plurality of requestors. The location server accommodates a variety of interfaces in communicating with the plurality of requestors. For example, for Internet protocol (IP) communication, the location server communicates with the plurality of requestors through a global computer network, *e.g.*, the Internet. As another example, for voice communication, the location server communicates with the plurality of requestors through a PSTN.

According to a preferred method of the present invention, the location server receives a location query for a network user from a requestor, retrieves the user's location from the location system, and forwards the location back to the requestor. Preferably, the location server also confirms that the requestor is authorized to receive the user's location. In an alternate preferred embodiment, if the location system provides the location in a "raw" form, not easily understood by the typical requestor (*e.g.*, x-y position coordinates), the method further includes translating the location from the raw form to a "displayable" form (*e.g.*, a street address, building name, or area name). The system component that executes this translation function is a mapping converter. The mapping converter can be

provisioned in several locations within the system, from the requestor's device to the devices of the plurality of requestors.

Accordingly, it is an object of the present invention to provide a requestor with the location of a wireless network user.

Another object of the present invention is to provide a wireless network user with the ability to automatically furnish specified requestors with the location of the network user.

Another object of the present invention is to provide a wireless network user with the ability to approve or deny access to the user's location information by a requestor who has not been pre-approved.

These and other objects of the present invention are described in greater detail in the detailed description of the invention, the appended drawings, and the attached claims.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of a system architecture that provides the location query service according to a preferred embodiment of the present invention.

Figure 2 is a flow chart tracing the steps for providing a location query service according to a preferred embodiment of the present invention.

Figure 3 is a schematic diagram of a system architecture that provides the location query service according to an alternate preferred embodiment, in which a device's location is periodically recorded in a location database 300.

Figure 4 is a schematic diagram of a system architecture that provides the location query service according to an alternate preferred embodiment of the present invention, with the mapping converter provisioned in alternate locations.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a location query service for use with a wireless network that tracks the locations of network users. The location query service provides a requestor with the location of a network user. In providing this service, the present invention contemplates future enhanced digital cellular networks, in which network users will use digital cellular handheld devices to access data from a global computer network, and in which digital cellular network providers will track the location of each network user.

Referring to Figure 1, the primary components of a preferred embodiment of the present invention include a location server 100 and a user wireless network 102. User wireless network 102 is in communication with a plurality of network devices 104. Location server 100 is in communication with user wireless network 102 and with a plurality of requestors 106. The plurality of requestors 106 employ any suitable means to communicate with location server 100, but preferably use at least one of a PC requestor 108, a wireless requestor 110, and a wireline requestor 112.

For communication between location server 100 and PC requestor 108, the present invention includes a global computer network 114. For communication between location server 100 and wireless requestor 110 (which has IP messaging capabilities), the present invention includes a requestor wireless network 116 and global computer network 114 for IP messaging, and requestor wireless network 116 and a PSTN 118 for voice communication. For communication between location server 100 and wireless requestor 112, the present invention includes PSTN 118.

According to a preferred embodiment of the present invention, user wireless network 102 is in communication with a location system 120 that provides the locations of the plurality of network devices 104. Location system 120 includes one or both of handheld location systems 122 and a network-based location system 124. Handheld location systems 122 are provisioned in wireless handheld devices 104. Network-based location systems 124 are part of user wireless network 102.

Location system 120 provides the location information, *e.g.*, position coordinates, of a handheld device, which indicates where a network user is located. Location system 120 can be a part of the wireless network or can be contained in the handheld devices. In the preferred embodiment of the present invention, as shown in Figure 1, location system 120 is both a part of the wireless network and is also contained in the handheld devices. For example, suitable methods of determining location as a part of the wireless network include Wireless Access Protocol (WAP) location services, Time Difference of Arrival (TDOA) location systems, Angle of Arrival (AOA) location systems, and other systems using triangulation across cell

sites or cell sectors. An example of a suitable location system in the handheld devices is a GPS.

If location system 120 provides location information in raw form, a further preferred embodiment of the present invention includes a mapping converter 126. An example of information in raw form would be GPS coordinates, with which the typical telephone user is unfamiliar. As used herein, "raw" refers to location information in a rudimentary form, such that a typical telephone user would find it difficult to understand. "Displayable" refers to location information easily understood by a typical network user. Although displayable may imply a visual communication, as used herein, the term extends to other forms of communication, such as audio-based communication. Mapping converter 126 includes a cross-referenced database that allows mapping converter 126 to translate raw location information into displayable location information. For example, the database of mapping converter 126 could include an entry associating coordinates "R-S" (raw information) with the description "101 Park Place" (displayable information).

Although shown as a separate component of the system in Figure 1, mapping converter 126 could be integral to a component described above. One of ordinary skill in the art would understand that the functions and structure of mapping converter 126 could be located in several different places, anywhere from location system 120 to the communication devices of the requestors 106. For example, mapping converter 126 could be located within network-based location system 124. As another example, mapping converter 126 could also be located within location

server 100. Regardless of where mapping converter 126 is provisioned, the desired end result is to deliver displayable location information to the plurality of requestors 106.

Location server 100 executes the service logic of the present invention, including receiving location queries from requestors 106, confirming the access levels of requestors 106, obtaining the location information of wireless network devices 104, and returning the location information to requestors 106. Although shown as a separate component in Figure 1, one of ordinary skill in the art would appreciate that location server 100 could be a part of another system component, such as user wireless network 102, PSTN 118, or global computer network 114.

In a representative embodiment, location server 100 consists of two components. The first component is a locating mechanism (such as location system 120) that determines locations of network devices 104 using various technologies (*e.g.*, GPS, triangulation, radio signal delay, and cell sector) and combinations thereof. The location mechanism can reside in a network device (*e.g.*, GPS) or within user wireless network 102. The location mechanism produces x-y coordinates that are typically transmitted to the second component of location server 100, which could be in the same box or could be connected via an IP network. The second component of location server 100 integrates the coordinate information into various mapping systems and provides an interface to other applications through various protocols, of which IP is the most common.

In a preferred embodiment of the present invention, location server 100 is in communication with a memory storage 128. Memory storage 128 is a database or other memory storage device that can record relationships between device identifications (*e.g.*, MINs) and network user identifications. In addition, memory storage contains authorized requestor lists for each device identification. Although Figure 1 shows memory storage 128 as a separate component of the system accessible to location server 100, memory storage 128 could be contained within location server 100.

Wireless handheld devices 104 operate over user wireless network 102. Familiar examples include pagers and cellular telephones. As a minimum, wireless handheld devices 104 provide network users with wireless communication and cooperate with user wireless network 102 to provide the location of the device. This cooperation may simply involve wireless transmissions to user wireless network 102 that enable network-based location system 124 to ascertain the locations of devices 104. Or, in conjunction with network-based location system 124, wireless handheld devices 104 may include handheld location systems 122, such as GPSs integral to the devices. To facilitate the alternate preferred embodiment in which a network user responds to off-list requests, wireless handheld devices 104 include messaging capabilities that can communicate a request for access, the identification of the unauthorized requestor, and a response by the network user. For example, such messaging capabilities can be audio-based, text-based, or graphical. Preferably, wireless handheld devices 104 are WAP-compatible thin clients having thin

browsers adapted to access global computer network 114 and to communicate with location server 100.

Global computer network 114 provides communication between TCP/IP requestor devices and location server 100. Preferably, global computer network 114 is the Internet. Also, preferably, network 114 provides a user-friendly interface, *e.g.*, a graphical user interface, through which a requestor can submit a location query. With a graphical user interface (GUI), the requestor device, such as PC requestor 108, is provisioned with software that cooperates with the GUI. Global computer network 114 also preferably supports communication with WAP-compatible wireless devices, such as wireless requestor 110. With these WAP-compatible wireless devices, requestor wireless network 116 provides communication between wireless requestor 110 and global computer network 114.

PSTN 118 provides communication between PSTN devices and location server 100. Along with requestor wireless network 116, PSTN 118 also provides communication between wireless requestors and location server 100. Location server 100 preferably supports a number of different protocols, at least one of which is IP. PSTN 118 preferably includes a Voice XML (Extensible Markup Language) server, which allows PSTN 118 to interface with location server 100 and provides a common markup language for supporting voice browsing applications. The Voice XML server could include, for example, an IVRU allowing a requestor to use a touch-tone pad to navigate the application.

The plurality of requestors 106 communicate with location server 100 using a device compatible with location server 100 or compatible with an interface between the requestors 106 and location server 100. Global computer network 114 and PSTN 118 are examples of these types of interfaces. Compatible devices include personal computers and IP wireless devices for global computer network 114, and standard wireline telephones for PSTN 118.

Together, the above components provide the location query service as outlined in the flowchart of Figure 2, according to a preferred embodiment of the present invention. While the system operation described herein and illustrated in the diagram and flowchart contains many specific details, these specific details should not be construed as limitations on the scope of the invention, but rather as examples of preferred embodiments thereof. As would be apparent to one of ordinary skill in the art, many other variations on the system operation are possible, including differently grouped and ordered method steps. Accordingly, the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims and their equivalents.

As shown in step 200, a requestor submits a location query to location server 100. The query includes at least an identification of the requestor and an identification of the network user about whom the requestor desires location information. Optionally, the query also includes a password, which enables a location query service provider to allow access to the service only by requestors who

pay for the service. Alternately, only the network user pays for the service and gives her authorized requestors a password to gain access to the service.

The requestor submits the query using any number of communications media supported by location server 100 and the requestor's individual communication device. For example, if the requestor uses a personal computer 108 linked to location server 100 through global computer network 114, the requestor could initiate the query using a graphical user interface. As another example, if the requestor uses a text messaging wireless device 110 linked to location server 100 through requestor wireless network 116 and global computer network 114, the requestor could initiate the query using a menu driven interface or a series of key sequence inputs. As another example, if the requestor uses a wireline telephone, the requestor could interact with an IVRU using the requestor's touch-tone keys to initiate the query.

In the preferred embodiment, the present invention accommodates the variety of ways in which a requestor can identify the network user that the requestor wishes to locate. For example, the requestor can give a telephone number, name, Internet address, or email address of the network user. In response, location server 100, global computer network 114, PSTN 118, or a separate system component consults a database cross referencing this information and translates the given identification into an identification of the network user's wireless device (*e.g.*, the MIN). As described later in this process, location server 100 provides

location system 120 with this device identification to search for the location of the device.

Once location server 100 has received the query, in step 202, location server 100 determines whether the requestor is an authorized requestor and whether the network user in question accepts requests from unauthorized off-list requestors to view the network user's location information. Location server 100 determines if the requestor is an authorized requestor by consulting memory storage 128, which contains a list that the network user provides. The list indicates which people (requestors) have access to the network user's location information. Although shown as a separate system component in Figure 1, memory storage 128 could be a part of location server 100, such that the list is stored in location server 100.

Along with the access list, the network user specifies a user preference dictating whether the network user will entertain requests to release her location information to requestors not on the access list. The user preference is also preferably stored in memory storage 128, but can be stored in any location accessible to location server 100. Location server 100 consults this user preference if the requestor is not on the access list.

If the requestor is unauthorized and the network user does not accept individual requests to release location information, in step 204a, location server 100 returns a message to the requestor reporting that the location query has been denied.

If the requestor is unauthorized, but the network user does entertain requests to release location information, in step 204b, location server 100 asks the network user if the requestor can receive the network user's location information. In asking for approval, location server 100 provides the network user with the identity of the requestor. If the network user chooses not to release her location information to the requestor, in step 204c, location server 100 returns a message to the requestor reporting that the location query has been denied.

If, in step 204b, the network user chooses to release her location information to the requestor, in step 204d, location server 100 proceeds with determining the location information of the wireless device. Likewise, if originally in step 202, location server determines that the requestor is on the access list and is authorized, location server 100 proceeds with determining the location information of the wireless device in step 204d.

In step 204d, location server 100 asks user wireless network 102 for the location information of the network user. In this inquiry, location server 100 includes the identification of the device corresponding to the network user.

In step 206a, user wireless network 102 uses location system 120 to determine the location of the specified network device. User wireless network 102 monitors wireless handheld devices that are powered on. In most instances, a network user simply turns on his wireless handheld device and, if it is a text messaging device, leaves the network interface open, perhaps to a web page. The initial accessing of the web page or the completion of any other wireless

transmission (*e.g.*, placing of a wireless telephone call) provides user wireless network 102 with location and identity information. In addition, each time the web page automatically refreshes, or each time the network user enters a browse command, user wireless network 102 receives updated location information. Thus, after location server 100 asks user wireless network 102 for the location of the network user, location system 120 of user wireless network 102 waits for the next transmission by the network device and determines the location information from that transmission. Alternately, instead of having location server 100 query user wireless network 102 for location information regarding a specific mobile device, location system 120 could be configured to continuously track devices and push location information to location server 100.

As another way to avoid a prolonged wait for the transmission providing the location information, in an alternate preferred embodiment, as shown in Figure 3, the present invention periodically records a device's location in a location database 300. Therefore, instead of activating location system 120 only in response to a request from location server 100, location system 120 of user wireless network 102 periodically updates location database 300 and always has location information available when location server 100 makes a request. In such a case, as shown in step 206b, location server 100 checks location database 300 for the location information of the network user. Although maintaining a database that is periodically updated for all network devices requires considerable amounts of data

storage, this alternate embodiment provides a more immediate response to the requestor.

In steps 206a or 206b, location system 120 of user wireless network 102 provides the location information in either raw or displayable forms. If location system 120 provides raw location information, such as x-y coordinates, the method of the present invention preferably further includes translating the raw data to a displayable message, easily comprehended by a typical requestor. Mapping converter 126 executes this translation and the method of the present invention varies depending upon where mapping converter 126 is provisioned (as described below and shown in Figure 4).

In step 208, if location system 120 provides raw location information and mapping converter 126 is provisioned in user wireless network 102, user wireless network 102 translates the raw location information to a displayable form before returning the location information to location server 100. If location system 120 provides the location information in displayable form, or if location system 120 provides the location information in raw form and user wireless network 102 does not have a mapping converter, user wireless network 102 simply forwards the location information.

In step 210, user wireless network 102 returns the location information, whether raw or displayable, to location server 100. In step 212, if the location information is in raw form and location server 100 contains mapping converter 126, location server 100 translates the location information to displayable form. Finally,

in step 214, location server 100 returns the location information of the network user back to the requestor.

Specific Examples of Preferred Embodiments

The benefits of the present invention apply to numerous situations in which a requestor wants to know the location of a network user. The most applicable situations involve network users that require a certain degree of supervision by another (the requestor). Examples of these types of network users include parolees, the elderly, and children. In each case, the present invention provides a location query service by making use of a wireless device that the network user would otherwise already be using for its primary purpose, *e.g.*, a cellular telephone used for personal voice communication.

As another specific example, the present invention could be implemented in the context of an instant messaging service. A user could have an instant messaging service configured to display only the friends of that user who are in the same city as the user. When a friend's name appears on the user's instant messaging screen, the user may want the option to query for the location of the friend to determine, for example, whether the friend is near enough to have lunch and, if so, to select a restaurant that is conveniently located for the friend and the user. Using the present invention to obtain the location information would save the user from having to send a message to the friend asking for the location of the friend. The location query of the present invention could be explicit or implicit,

occurring in the background of the instant messaging service, as a result of a configuration option or an action in the application.

The foregoing disclosure of embodiments of the present invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many variations and modifications of the embodiments described herein will be obvious to one of ordinary skill in the art in light of the above disclosure. The scope of the invention is to be defined only by the claims appended hereto, and by their equivalents.